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**CHEMISTRY
HIGHER LEVEL
PAPER 1**

Thursday 16 May 2013 (afternoon)

1 hour

INSTRUCTIONS TO CANDIDATES

- Do not open this examination paper until instructed to do so.
- Answer all the questions.
- For each question, choose the answer you consider to be the best and indicate your choice on the answer sheet provided.
- The periodic table is provided for reference on page 2 of this examination paper.
- The maximum mark for this examination paper is *[40 marks]*.

The Periodic Table

1	2	3	4	5	6	7	0														
1 H 1.01		Atomic number					2 He 4.00														
3 Li 6.94		Element					9 F 19.00														
4 Be 9.01		Relative atomic mass					8 O 16.00														
11 Na 22.99							7 N 14.01														
12 Mg 24.31							6 C 12.01														
							5 B 10.81														
							13 Al 26.98														
							14 Si 28.09														
							15 P 30.97														
							16 S 32.06														
							17 Cl 35.45														
							18 Ar 39.95														
19 K 39.10		20 Ca 40.08	21 Sc 44.96	22 Ti 47.90	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.71	29 Cu 63.55	30 Zn 65.37	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80			
37 Rb 85.47		38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc 98.91	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.40	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.90	54 Xe 131.30			
55 Cs 132.91		56 Ba 137.34	57 † La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.85	75 Re 186.21	76 Os 190.21	77 Ir 192.22	78 Pt 195.09	79 Au 196.97	80 Hg 200.59	81 Tl 204.37	82 Pb 207.19	83 Bi 208.98	84 Po (210)	85 At (210)	86 Rn (222)			
87 Fr (223)		88 Ra (226)	89 ‡ Ac (227)																		
				†																	
				58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm 146.92	62 Sm 150.35	63 Eu 151.96	64 Gd 157.25	65 Tb 158.92	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97				
				‡																	
				90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np (237)	94 Pu (242)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (254)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)				

1. How many atoms are present in 0.10 mol of $\text{PtCl}_2(\text{NH}_3)_2$?

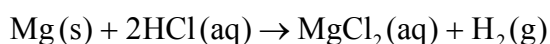
- A. 6.0×10^{22}
- B. 3.0×10^{23}
- C. 6.6×10^{23}
- D. 6.6×10^{24}

2. What mass of carbon dioxide, $\text{CO}_2(\text{g})$, in g, is produced when 5.0 g of calcium carbonate, $\text{CaCO}_3(\text{s})$, reacts completely with hydrochloric acid, $\text{HCl}(\text{aq})$?



- A. 0.050
- B. 2.2
- C. 4.4
- D. 5.0

3. The volume occupied by one mole of an ideal gas at 273 K and $1.01 \times 10^5 \text{ Pa}$ is $22.4 \text{ dm}^3 \text{ mol}^{-1}$. What volume of hydrogen, in dm^3 , is produced when excess magnesium ribbon reacts with 100 cm^3 of 2.00 mol dm^{-3} hydrochloric acid?



- A. 0.100
- B. 2.24
- C. 4.48
- D. 22.4

4. Which is the correct order of the stages of operation in the mass spectrometer?
 - A. vaporization, ionization, acceleration, deflection, detection
 - B. vaporization, ionization, detection, deflection, acceleration
 - C. ionization, vaporization, acceleration, deflection, detection
 - D. ionization, deflection, acceleration, detection, vaporization

5. Which species has the electron configuration of $1s^2 2s^2 2p^6 3s^2 3p^6 3d^8$?
 - A. Ni
 - B. Ni^{2+}
 - C. Fe
 - D. Cu^{2+}

6. Element X is in group 5 and period 4 of the periodic table. Which statement is correct?
 - A. X has 5 occupied energy levels.
 - B. X can form ions with 3– charge.
 - C. X is a transition element.
 - D. X has 4 valence electrons.

7. Which statements are correct for the alkali metals Li to Cs?
- I. Melting point increases
 - II. First ionization energy decreases
 - III. Ionic radius increases
- A. I and II only
 - B. I and III only
 - C. II and III only
 - D. I, II and III
8. Which statements about $[\text{Ag}(\text{NH}_3)_2]^+$ are correct?
- I. NH_3 forms a dative covalent (co-ordinate) bond with Ag^+ .
 - II. The formation of the bond between NH_3 and Ag^+ is an example of a Lewis acid–base reaction.
 - III. Ag^+ is the ligand in this complex ion.
- A. I and II only
 - B. I and III only
 - C. II and III only
 - D. I, II and III
9. Which is the best description of a metallic bond?
- A. Electrostatic attraction between oppositely charged ions
 - B. Electrostatic attraction between a pair of electrons and positively charged nuclei
 - C. Electrostatic attraction between a lattice of positive ions and delocalized electrons
 - D. Electrostatic attraction for a bonding pair of electrons which have been supplied by one of the atoms

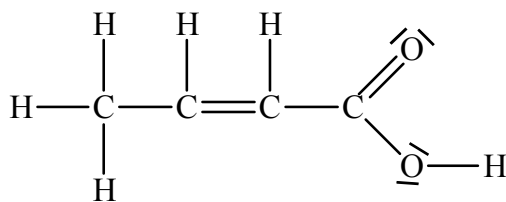
10. Which statements about the structure and bonding of silicon dioxide are correct?

	Structure	Bonding
A.	Silicon dioxide forms a giant covalent network.	Each oxygen atom is covalently bonded to two silicon atoms.
B.	Silicon dioxide molecules are V-shaped or bent.	Each silicon atom is covalently bonded to two oxygen atoms.
C.	Silicon dioxide molecules are linear.	A double covalent bond exists between silicon and oxygen atoms.
D.	Silicon dioxide forms a giant covalent network.	Each oxygen atom is covalently bonded to four silicon atoms.

11. Which series shows **increasing** boiling points?

- A. $\text{CH}_3\text{CH}_2\text{CH}_3 < \text{CH}_3\text{CH}_2\text{OH} < \text{CH}_3\text{CHO}$
- B. $\text{CH}_3\text{CHO} < \text{CH}_3\text{CH}_2\text{CH}_3 < \text{CH}_3\text{CH}_2\text{OH}$
- C. $\text{CH}_3\text{CH}_2\text{OH} < \text{CH}_3\text{CHO} < \text{CH}_3\text{CH}_2\text{CH}_3$
- D. $\text{CH}_3\text{CH}_2\text{CH}_3 < \text{CH}_3\text{CHO} < \text{CH}_3\text{CH}_2\text{OH}$

12. How many sigma (σ) and pi (π) bonds are there in the following molecule?



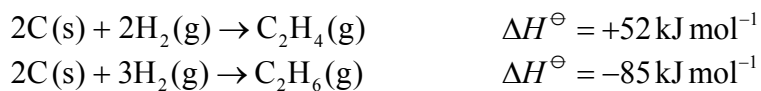
	σ bonds	π bonds
A.	9	2
B.	9	4
C.	11	2
D.	11	4

13. Which species have delocalized π electrons?

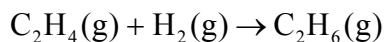
- I. CH_3COCH_3
 II. NO_2^-
 III. CO_3^{2-}

- A. I and II only
 B. I and III only
 C. II and III only
 D. I, II and III
14. The specific heat capacity of aluminium is $0.900 \text{ J g}^{-1} \text{ K}^{-1}$. What is the heat energy change, in J, when 10.0 g of aluminium is heated and its temperature increases from 15.0°C to 35.0°C ?
- A. +180
 B. +315
 C. +1800
 D. +2637

15. Enthalpy changes of reaction are provided for the following reactions.



What is the enthalpy change, in kJ mol^{-1} , for the reaction between ethene and hydrogen?

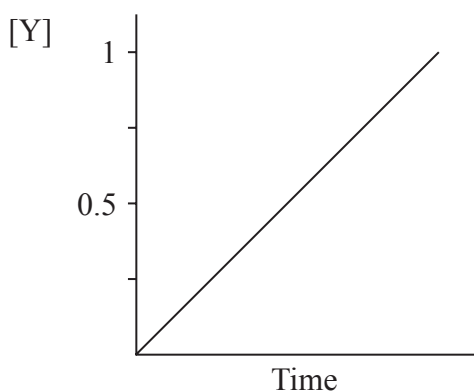


- A. -137
- B. -33
- C. +33
- D. +137
16. Which reaction has an enthalpy change equal to the standard enthalpy change of combustion?
- A. $\text{C}_3\text{H}_8\text{(g)} + 5\text{O}_2\text{(g)} \rightarrow 3\text{CO}_2\text{(g)} + 4\text{H}_2\text{O(g)}$
- B. $\text{C}_3\text{H}_8\text{(g)} + 5\text{O}_2\text{(g)} \rightarrow 3\text{CO}_2\text{(g)} + 4\text{H}_2\text{O(l)}$
- C. $2\text{C}_4\text{H}_{10}\text{(g)} + 13\text{O}_2\text{(g)} \rightarrow 8\text{CO}_2\text{(g)} + 10\text{H}_2\text{O(l)}$
- D. $\text{C}_5\text{H}_{12}\text{(g)} + 8\text{O}_2\text{(g)} \rightarrow 5\text{CO}_2\text{(g)} + 6\text{H}_2\text{O(g)}$
17. Which reactions/processes have a positive entropy change, ΔS^\ominus ?
- I. $\text{NaCl(s)} \rightarrow \text{NaCl(aq)}$
- II. $\text{Na}_2\text{CO}_3\text{(s)} + 2\text{HCl(aq)} \rightarrow \text{CO}_2\text{(g)} + 2\text{NaCl(aq)} + \text{H}_2\text{O(l)}$
- III. $\text{AgNO}_3\text{(aq)} + \text{NaCl(aq)} \rightarrow \text{AgCl(s)} + \text{NaNO}_3\text{(aq)}$
- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

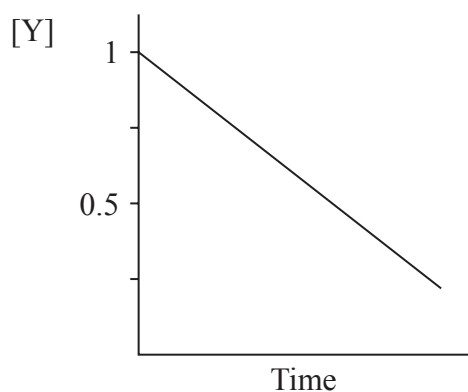
18. Which compound has the most positive lattice enthalpy of dissociation?
- A. NaCl
 - B. NaBr
 - C. MgCl_2
 - D. MgBr_2
19. Which statements explain the increase in the rate of a reaction when the temperature is increased?
- I. More particles have energy greater than the activation energy.
 - II. The frequency of collisions increases.
 - III. The activation energy decreases.
- A. I and II only
 - B. I and III only
 - C. II and III only
 - D. I, II and III

20. Experimental data shows that a reaction in which Y is a reactant is first order with respect to Y. Which graph shows this first-order relationship?

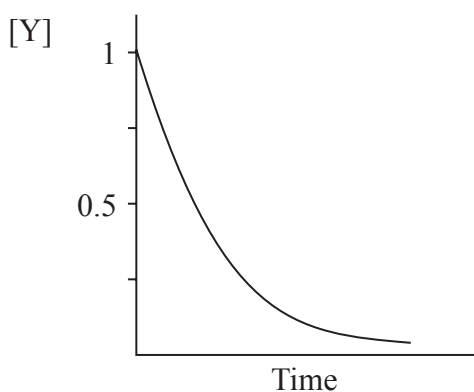
A.



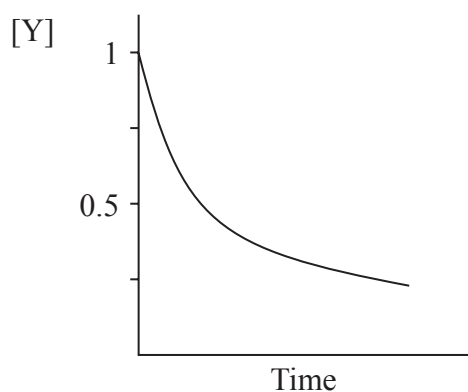
B.



C.



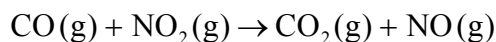
D.



21. Which statement about a reaction best describes the relationship between the temperature, T , and the rate constant, k ?

- A. As T increases, k decreases linearly.
- B. As T increases, k decreases non-linearly.
- C. As T increases, k increases linearly.
- D. As T increases, k increases non-linearly.

22. Carbon monoxide and nitrogen dioxide react to form carbon dioxide and nitrogen monoxide according to the following equation.

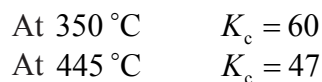
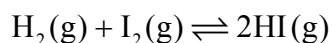


The reaction occurs in a series of steps. The equation for the rate-determining step is given below.



What is the rate expression for this reaction?

- A. $\text{rate} = k[\text{CO(g)}][\text{NO}_2\text{(g)}]$
 - B. $\text{rate} = k[\text{NO}_2\text{(g)}]^2$
 - C. $\text{rate} = k[\text{NO}_3\text{(g)}][\text{NO(g)}]$
 - D. $\text{rate} = k[\text{CO}_2\text{(g)}][\text{NO(g)}]$
23. Hydrogen and iodine react in a closed vessel to form hydrogen iodide.



Which statement describes and explains the conditions that favour the formation of hydrogen iodide?

- A. Increased temperature as the forward reaction is exothermic, and increased pressure as there are two gaseous reactants and only one gaseous product
- B. Increased temperature as the forward reaction is endothermic, and pressure has no effect as there are equal amounts, in mol, of gaseous reactants and products
- C. Decreased temperature as the forward reaction is exothermic, and decreased pressure as there are two moles of gaseous product but only one mole of each gaseous reactant
- D. Decreased temperature as the forward reaction is exothermic, and pressure has no effect as there are equal amounts, in mol, of gaseous reactants and products

24. Which change would increase the vapour pressure of a liquid in equilibrium with its vapour in a sealed container?
- Increasing the temperature while keeping the surface area of the liquid constant
 - Increasing the surface area of the liquid while maintaining a constant temperature
 - Adding more liquid at constant temperature
 - Adding more of the vapour at constant temperature
25. Which compound has the highest enthalpy of vaporization?
- CO₂
 - NH₃
 - H₂S
 - H₂O
26. Which of the following is an example of a Lewis acid–base reaction, but not a Brønsted–Lowry acid–base reaction?
- $2\text{CrO}_4^{2-}(\text{aq}) + 2\text{H}^+(\text{aq}) \rightarrow \text{Cr}_2\text{O}_7^{2-}(\text{aq}) + \text{H}_2\text{O}(\text{l})$
 - $\text{Co}(\text{H}_2\text{O})_6^{2+}(\text{aq}) + 4\text{HCl}(\text{aq}) \rightarrow \text{CoCl}_4^{2-}(\text{aq}) + 4\text{H}^+(\text{aq}) + 6\text{H}_2\text{O}(\text{l})$
 - $\text{NH}_3(\text{aq}) + \text{H}^+(\text{aq}) \rightarrow \text{NH}_4^+(\text{aq})$
 - $\text{CH}_3\text{COO}^-(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{CH}_3\text{COOH}(\text{aq}) + \text{OH}^-(\text{aq})$
27. Which list contains only strong bases?
- ammonia, sodium hydroxide, ethylamine
 - potassium hydroxide, ammonia, sodium hydroxide
 - lithium hydroxide, potassium hydroxide, barium hydroxide
 - ammonia, ethylamine, barium hydroxide

28. The pK_b value of ammonia is 4.75 at 298 K. What is the pK_a value of the ammonium ion?

- A. $\frac{10^{-14}}{4.75}$
- B. $\frac{14.00}{4.75}$
- C. $14.00 - 4.75$
- D. $\frac{10^{-14}}{10^{-4.75}}$

29. The K_a values of four weak acids W, X, Y and Z are listed below.

$$W \quad K_a = 1.35 \times 10^{-3}$$

$$X \quad K_a = 4.47 \times 10^{-2}$$

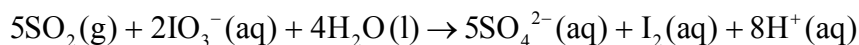
$$Y \quad K_a = 9.33 \times 10^{-6}$$

$$Z \quad K_a = 1.47 \times 10^{-5}$$

What is the correct order of **increasing** strength as acids?

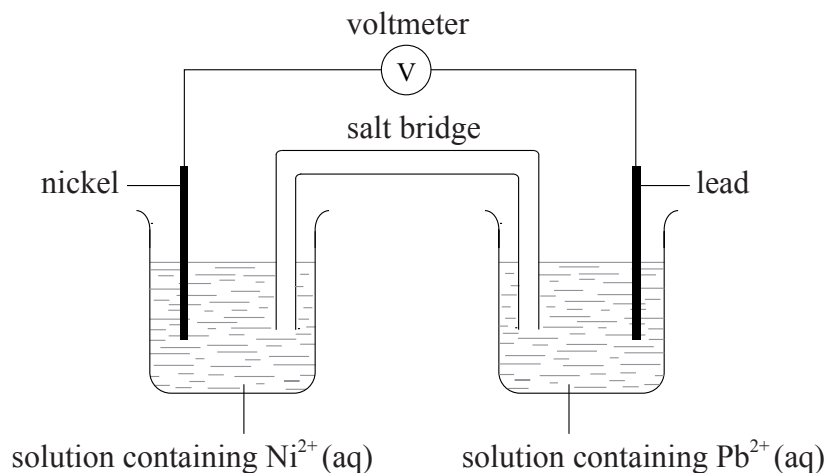
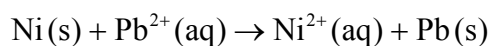
- A. $X < W < Z < Y$
- B. $W < Z < X < Y$
- C. $Y < X < Z < W$
- D. $Y < Z < W < X$

30. Which is the oxidizing agent in the following reaction?



- A. SO_2
- B. IO_3^-
- C. H_2O
- D. SO_4^{2-}

31. The overall reaction in the voltaic cell below is:

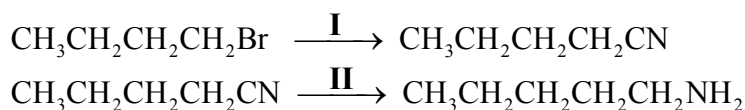


Which statement is correct for the nickel half-cell?

- A. Nickel is the positive electrode (cathode) and is reduced.
 - B. Nickel is the negative electrode (anode) and is reduced.
 - C. Nickel is the positive electrode (cathode) and is oxidized.
 - D. Nickel is the negative electrode (anode) and is oxidized.
32. Which statement is correct for electroplating an object with gold?
- A. The object must be the negative electrode (cathode).
 - B. The negative electrode (cathode) must be gold.
 - C. The object must be the positive electrode (anode).
 - D. The gold electrode must be pure.

33. What are possible products of the incomplete combustion of propan-2-ol?
- A. carbon monoxide, hydrogen and carbon
 - B. carbon dioxide, carbon and hydrogen
 - C. carbon, carbon monoxide and water
 - D. carbon dioxide and water only
34. Which equation represents a propagation step in the mechanism for the reaction between ethane, C_2H_6 , and chlorine, Cl_2 , in the presence of sunlight/UV?
- A. $\text{C}_2\text{H}_6 + \text{Cl}\cdot \rightarrow \text{C}_2\text{H}_5\cdot + \text{HCl}$
 - B. $\text{C}_2\text{H}_6 + \text{Cl}\cdot \rightarrow \text{C}_2\text{H}_5\text{Cl} + \text{H}\cdot$
 - C. $\text{Cl}_2 \rightarrow 2\text{Cl}\cdot$
 - D. $\text{C}_2\text{H}_5\cdot + \text{Cl}\cdot \rightarrow \text{C}_2\text{H}_5\text{Cl}$
35. What is the name of $\text{CH}_3\text{CH}_2\text{CH}_2\text{CN}$ applying IUPAC rules?
- A. Butanamine
 - B. Butanamide
 - C. Propanenitrile
 - D. Butanenitrile

36. 1-bromobutane, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Br}$, can be converted to 1-aminopentane, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{NH}_2$, in a two-step process.



What are the reagents **I** and **II**?

	I	II
A.	ammonia	hydrogen with nickel
B.	ammonia	hydrochloric acid
C.	potassium cyanide	ammonia
D.	potassium cyanide	hydrogen with nickel

37. Which halogenoalkane reacts the fastest with hydroxide ions in a nucleophilic substitution reaction?

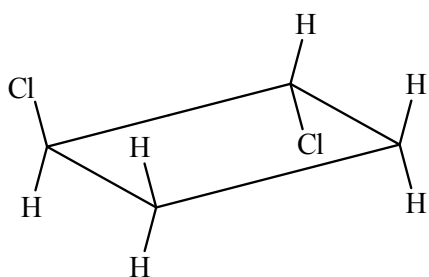
- A. 1-chlorobutane
- B. 2-chloro-2-methylpropane
- C. 1-iodobutane
- D. 2-iodo-2-methylpropane

38. Ethylamine, $\text{CH}_3\text{CH}_2\text{NH}_2$, reacts with propanoic acid, $\text{CH}_3\text{CH}_2\text{COOH}$. Initially a salt is formed which, when heated at 200°C , can form an organic product. What is the structural formula of the organic product?

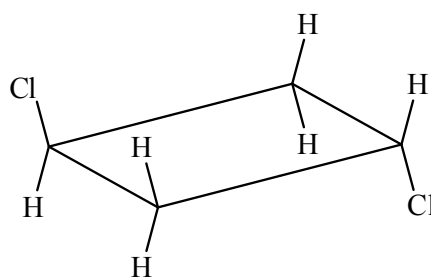
- A. $\text{CH}_3\text{CH}_2\text{NHCOCH}_2\text{CH}_3$
- B. $\text{CH}_3\text{CH}_2\text{NHCOOCH}_2\text{CH}_3$
- C. $\text{CH}_3\text{CH}_2\text{COONHCH}_2\text{CH}_3$
- D. $\text{CH}_3\text{CH}_2\text{COOCH}_2\text{CH}_3$

39. Which structure is a geometric isomer of *cis*-1,2-dichlorocyclobutane?

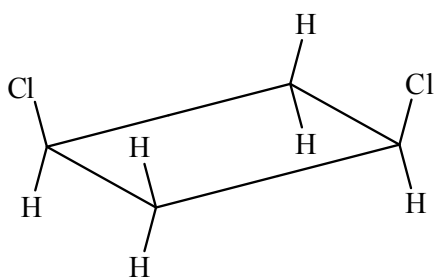
A.



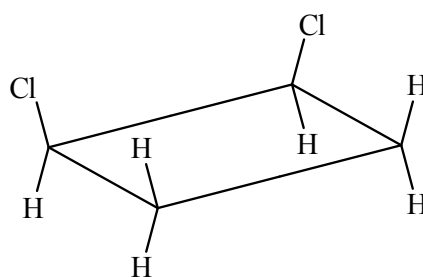
B.



C.



D.



40. Using an accurate pH meter, the pH of lemonade was found to be 2.30. Some students deduced the pH of the lemonade after titration with a 0.10 mol dm^{-3} sodium hydroxide solution. Their determined values of pH were 2.4, 2.5, 2.4 and 2.4. What is the best description of the precision and accuracy of these measurements?

	Precision	Accuracy
A.	precise	inaccurate
B.	not precise	inaccurate
C.	precise	accurate
D.	not precise	accurate